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# RESEARCH MEMORANDUM

for the

Air Materiel Command, U. S. Air Force

DITCHING TESTS OF A  $\frac{1}{15}$ -SCALE MODEL

OF THE FAIRCHILD C-82 AIRPLANE

By

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SUMMARY

Tests of a  $\frac{1}{15}$ -scale dynamically similar model of the Fairchild C-82 airplane were made to determine its ditching characteristics and the safest ditching procedure. The tests were conducted in calm water at the Langley tank no. 2 monorail.

Various landing attitudes, speeds, and simulated conditions of damage were investigated. The ditching characteristics were determined from visual observations, motion-picture records, and time-history acceleration records. It was concluded from the model tests that the best ditching with the C-82 airplane could be made by contacting the water as near the stall angle as possible without losing adequate control. The landing flaps should be full down. If the paratainer hatch and aft-cargo doors fail as expected in a ditching, there will be a large inrush of water into the cargo compartment, which makes this location a very hazardous ditching station. The airplane will settle in the water rapidly to the level of the wings with only gradual changes in attitude. The maximum longitudinal deceleration will be between 1.2g and 1.7g in a calm-water ditching.

INTRODUCTION

An investigation of the ditching characteristics and safest ditching procedure for the Fairchild C-82 airplane was made at Langley tank no. 2 at the request of the Air Materiel Command, U. S. Air Force. Various landing attitudes, speeds, and simulated conditions of damage were investigated in calm-water landing tests with a dynamically similar model of the airplane.

Data on the airplane were obtained from the Fairchild Engine and Airplane Corporation, the Air Materiel Command, and reference 1.

## APPARATUS AND PROCEDURE

### Description of Model

A  $\frac{1}{15}$ -scale dynamically similar model of the Fairchild C-82 airplane having a wing span of 85.1 inches and a length of 61.7 inches was used in the tests. A three-view drawing of the airplane is shown in figure 1 and photographs of the model are given in figure 2. The model was constructed principally of balsa wood with spruce used where added strength was necessary and was ballasted internally to obtain scale weight and moments of inertia. The large open cargo compartment and passages in the nose of the airplane were duplicated in the model so that any flow of water through the model would be similar to that encountered in the full-scale airplane.

The fuselage of this airplane has an unusually large flat bottom. The impact loads encountered on such a surface will probably be high so the nose-wheel doors, aft-cargo doors, and paratainer hatch are expected to fail in a ditching. Structural failure of these parts was simulated by complete removal.

### Test Methods and Equipment

The test methods and equipment used were similar to those used in previous ditching investigations. The model was attached to a launching carriage on the Langley tank no. 2 monorail at the desired landing attitude with the control surfaces set to hold this attitude in flight. The model was then catapulted into the air, and the preset control surfaces kept the model at approximately the desired attitude during the glide onto the water.

The results of the tests were obtained from visual observations, motion-picture records, and time-history acceleration records. Both longitudinal and vertical acceleration records were obtained. Accelerations were measured with a single-component accelerometer located in the model near the pilot's position. To obtain the two components of acceleration, the accelerometer was rotated and the tests repeated.

### Test Conditions

All values given refer to the full-scale airplane.

Gross weight.- A gross weight of 50,000 pounds was simulated in the tests. In using this weight the airplane was considered loaded with a complement of 42 paratroopers.

Location of the center of gravity.- The center of gravity was located at 25 percent of the mean aerodynamic chord and 6 inches below the thrust line.

Landing attitude.- Ditchings were made at three landing attitudes:  $2^\circ$ ,  $7^\circ$ , and  $12^\circ$ . The  $2^\circ$  attitude is near the three-wheel attitude and the  $12^\circ$  attitude is near the stall attitude. The  $7^\circ$  attitude is an arbitrary intermediate selection.

Landing gear.- The tests simulated ditchings with the landing gear retracted.

Flaps.- Landing flaps were fixed in the full-down position.

Landing speeds.- The landing speeds used in the tests are listed in table I. They are speeds at which the model was just air-borne and are within  $\pm 10$  miles per hour of the speeds computed using lift curves from reference 1.

Conditions of simulated damage.- The model was tested at the following conditions of simulated damage:

- (a) No damage (See fig. 2.)
- (b) Simulated failure of the nose-wheel doors and the aft-cargo doors (See fig. 3.)
- (c) Simulated failure of the nose-wheel doors, the aft-cargo doors, and the paratainer hatch (See fig. 4.)

## RESULTS AND DISCUSSION

A summary of the results of the tests is presented in table I. The symbols used in the table are defined as follows:

- p porpoised - the model undulated about the lateral axis with some part always in contact with the water
- r settled rapidly - the vertical displacement of the model increased rapidly with a corresponding rapid decrease in forward motion
- s skipped - the model cleared the water surface entirely with an undulating motion about the lateral axis

u trimmed up - the attitude of the model increased immediately after contact with the water

Photographs showing the characteristic behavior of the model are given in figures 5 and 6. Typical time histories of attitude, longitudinal and vertical accelerations, and longitudinal and vertical displacement are given in figures 7 and 8.

#### Effect of Landing Flaps

The landing flaps had no effect on the ditching behavior because they are located high on the airplane and are clear of the water during the high-speed portion of the ditching run. (See figs. 5 and 6.) For this reason the flaps were tested fixed in the full-down position only.

#### Effect of Damage and Attitude

When tested at condition A, the undamaged condition, the ditching behavior of the model was characterized by a trimming up after contact that was caused by suction under the aft end of the fuselage. At the  $2^\circ$  landing attitude, the model trimmed up violently immediately upon contact with the water. This caused the model to skip. After the skip, as the speed decreased, the model porpoised. At the  $7^\circ$  and  $12^\circ$  landing attitudes, the trimming-up motion was not as violent as at the  $2^\circ$  attitude. This may be seen by comparing figures 7(a) and 8. The model did not skip but settled rapidly. Since water did not enter the model when tested undamaged, it floated with the wing high above the water. The maximum longitudinal deceleration encountered was about  $2.2g$  obtained at the  $7^\circ$  attitude. The maximum vertical acceleration (measured only for the  $2^\circ$  attitude landings where the skipping occurred) was  $2.6g$ . (See figs. 6 and 8.)

Damage condition B had the nose-wheel doors and aft-cargo doors removed. Removal of the nose-wheel doors had no apparent effect on the ditching behavior, regardless of the other damage simulated, since they were not immersed until the model had almost stopped. (See figs. 5 and 6.) Removal of the aft-cargo doors greatly reduced the suction force on the fuselage. Various results obtained in tests at condition B are illustrated in figure 7(b). The model trimmed up at contact (but not as violently as when undamaged), skipped, and then porpoised as the speed decreased, at all attitudes tested. During the skipping and porpoising the model did not sink far below the surface of the water due to the dynamic lift. When this lift decreased at the end of the run the model was flooded through the large open cargo doors and sank to the level of the wings. The maximum longitudinal deceleration encountered at damage condition B, regardless of attitude, was  $1g$ . The maximum vertical acceleration (measured only in the skips at the  $7^\circ$  attitude) was  $1g$ .

Damage condition C had the nose-wheel doors, aft-cargo doors, and paratainer hatch removed. When both the aft-cargo doors and paratainer hatch were removed, the trimming up was practically eliminated. At the  $2^\circ$  attitude the model trimmed up only slightly, while at the  $7^\circ$  and  $12^\circ$  attitudes the model trimmed down upon contact with the water. (See fig. 7(c).) In each case after the model made contact with the water it settled rapidly to the level of the wings with only gradual changes in attitude. The large inrush of water through the open paratainer hatch during the ditching run and the flooding through the large cargo doors at the end of the run accounted for the rapid settling of the model. The longitudinal decelerations at this damage condition varied from 1.2g at the  $12^\circ$  attitude to 2.4g at the  $2^\circ$  attitude.

Of the three damage conditions tested, it is believed damage condition C simulated most accurately the damage that will occur. The large inrush of water through the paratainer hatch during the ditching run and the flooding through the cargo doors at the end of the run will probably be repeated in full-scale ditchings. The full-scale airplane will not have as much buoyancy as the balsa model so it will sink even lower in the water. This rapid sequence of events will be dangerous to the occupants of the cargo compartment. However, the pilot's compartment will probably be relatively safe since it is located high on the airplane.

The motions of the model and the length of the ditching runs were similar at the  $7^\circ$  and  $12^\circ$  attitudes. The maximum longitudinal deceleration measured at the  $7^\circ$  attitude was 1.7g, while at the  $12^\circ$  attitude it was 1.2g. Normally, the  $12^\circ$  attitude would be recommended because of the lower decelerations, but in conferring with pilots of this type airplane it was learned that near the stall attitude control is poor and the sinking speeds are excessive. For this reason the ditching attitude is recommended to be as near the stall angle as possible without losing too much control.

### CONCLUSIONS

Conclusions based on the model investigation are as follows:

1. To obtain the best ditching with the Fairchild C-82 airplane, it should be made to contact the water at as near the stall angle as possible without losing adequate control. The landing flaps should be full down.
2. If the paratainer hatch and aft-cargo doors fail as expected in a ditching, there will be a large inrush of water into the cargo compartment which makes this location a very hazardous ditching station.

3. The airplane will settle into the water rapidly to the level of the wings with only gradual changes in attitude. The maximum longitudinal deceleration will be between 1.2g and 1.7g in a calm-water ditching.

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#### REFERENCE

1. Schuldenfrei, Marvin, and Weil, Joseph: Wind-Tunnel Tests of the 1/14-Scale Powered Model of the Fairchild XC-82 Airplane. I - Preliminary Investigation. NACA MR, Army Air Forces, May 25, 1943.

TABLE I  
SUMMARY OF RESULTS OF DITCHING TESTS IN CALM WATER OF A  $\frac{1}{15}$ -SCALE MODEL

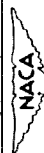
OF THE FAIRCHILD C-82 AIRPLANE

Gross weight, 50,000 lb; landing flaps, full down; all values, full scale

Landing attitude, deg	2			7			12		
Landing speed, mph	125			104			90		
Damage condition	Maximum longitudinal deceleration (g)	Length of run (ft)	Motions of model (a)	Maximum longitudinal deceleration (g)	Length of run (ft)	Motions of model (a)	Maximum longitudinal deceleration (g)	Length of run (ft)	Motions of model (a)
A No damage	1.2	720	usp	2.2	315	ur	1.0	375	ur
B Simulated failure of nose-wheel doors and aft-cargo doors	1.0	1320	usp	0.8	735	usp	0.9	645	usp
C Simulated failure of nose-wheel doors, aft-cargo doors, and paratainer hatch	2.4	450	ur	1.7	345	r	1.2	300	r

<sup>a</sup> Motions of the model are denoted by the following symbols:

p porpoised  
r settled rapidly  
s skipped  
u trimmed up



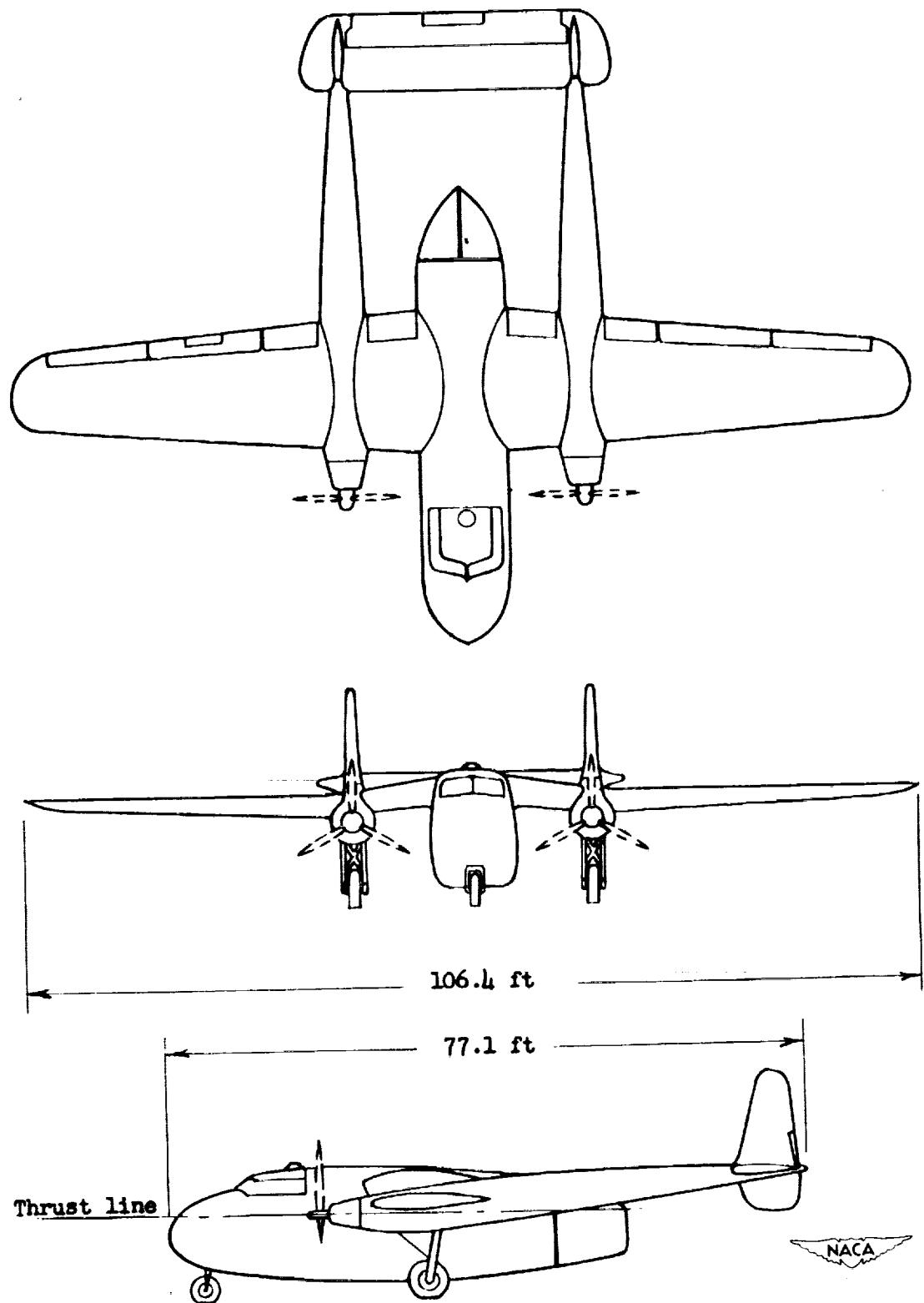
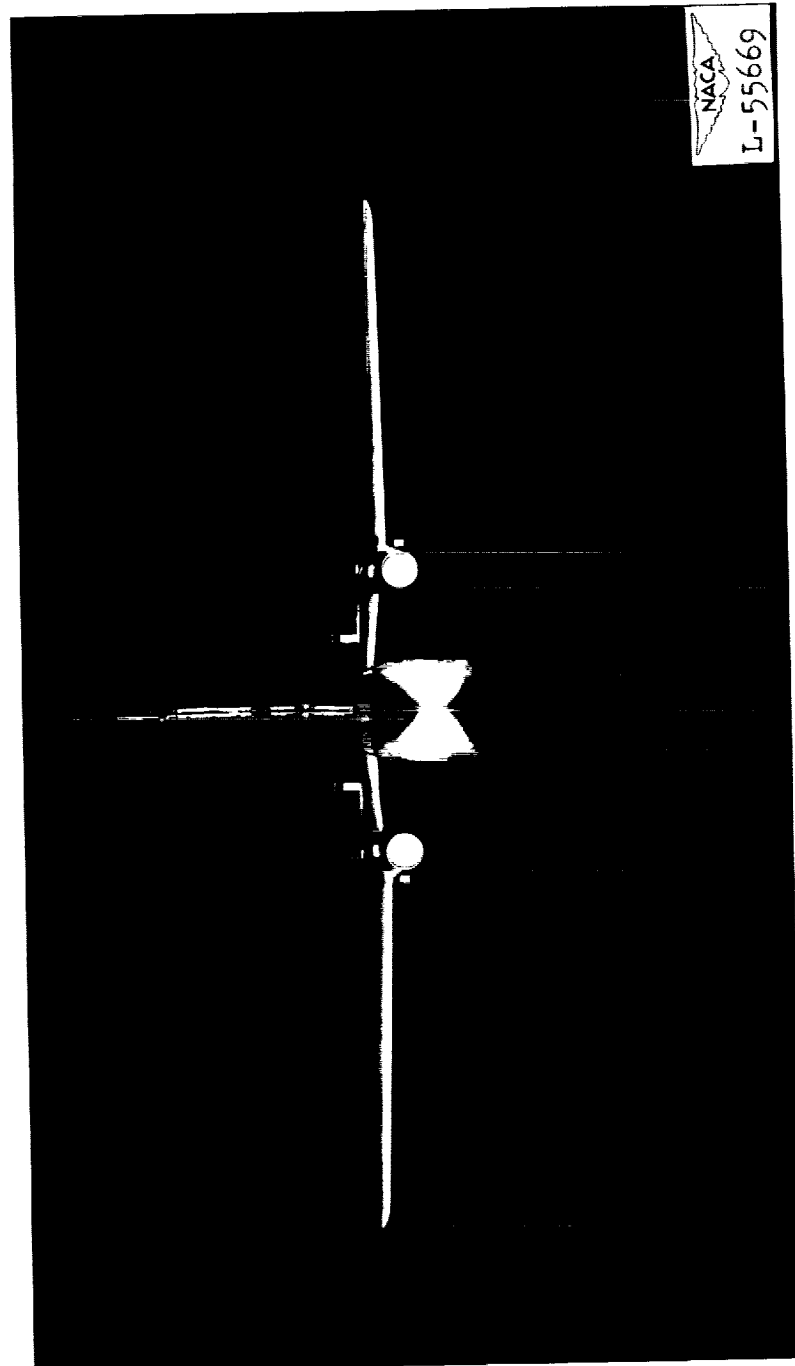
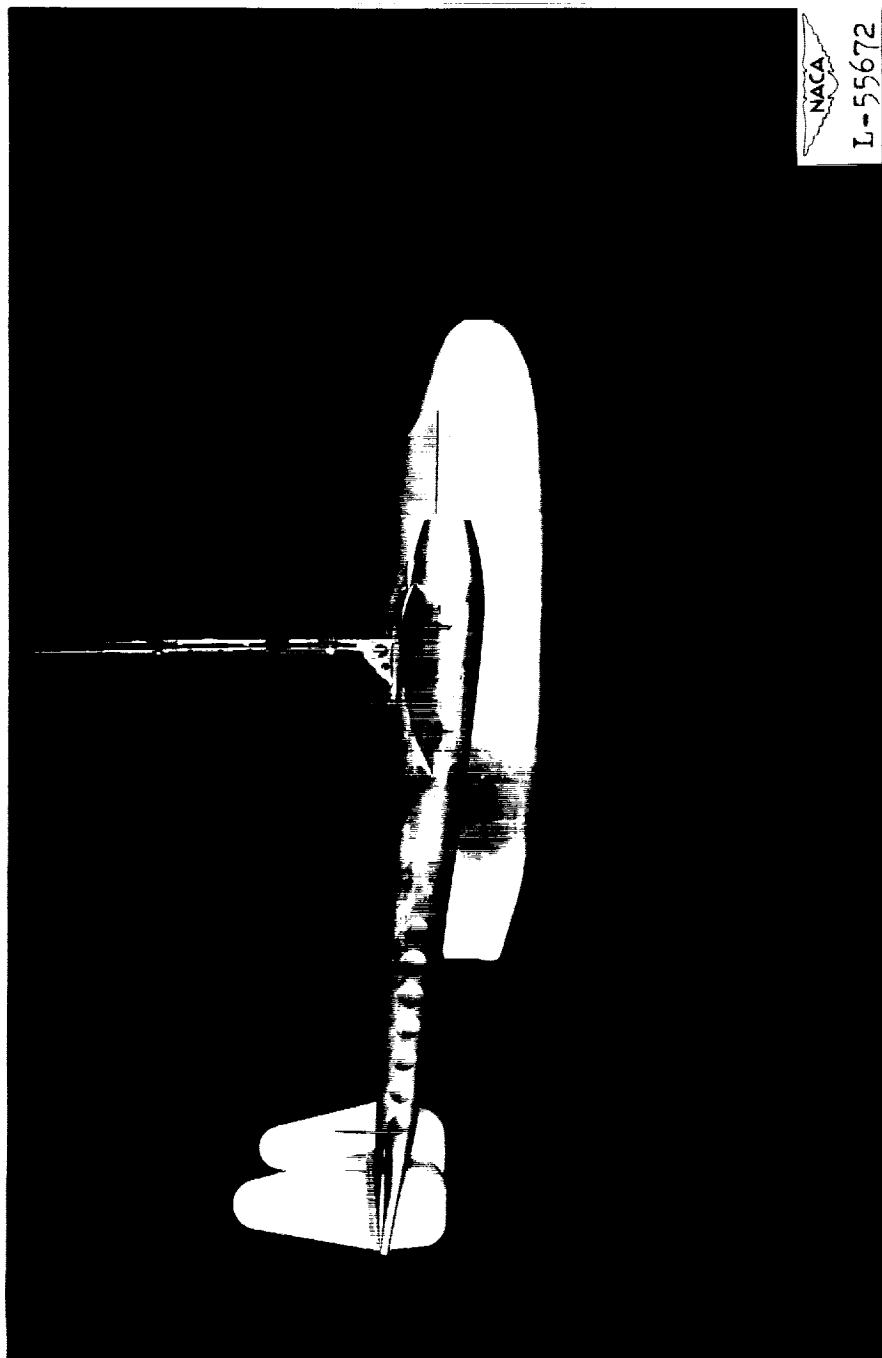


Figure 1.- Three-view drawing of the Fairchild C-82 airplane.



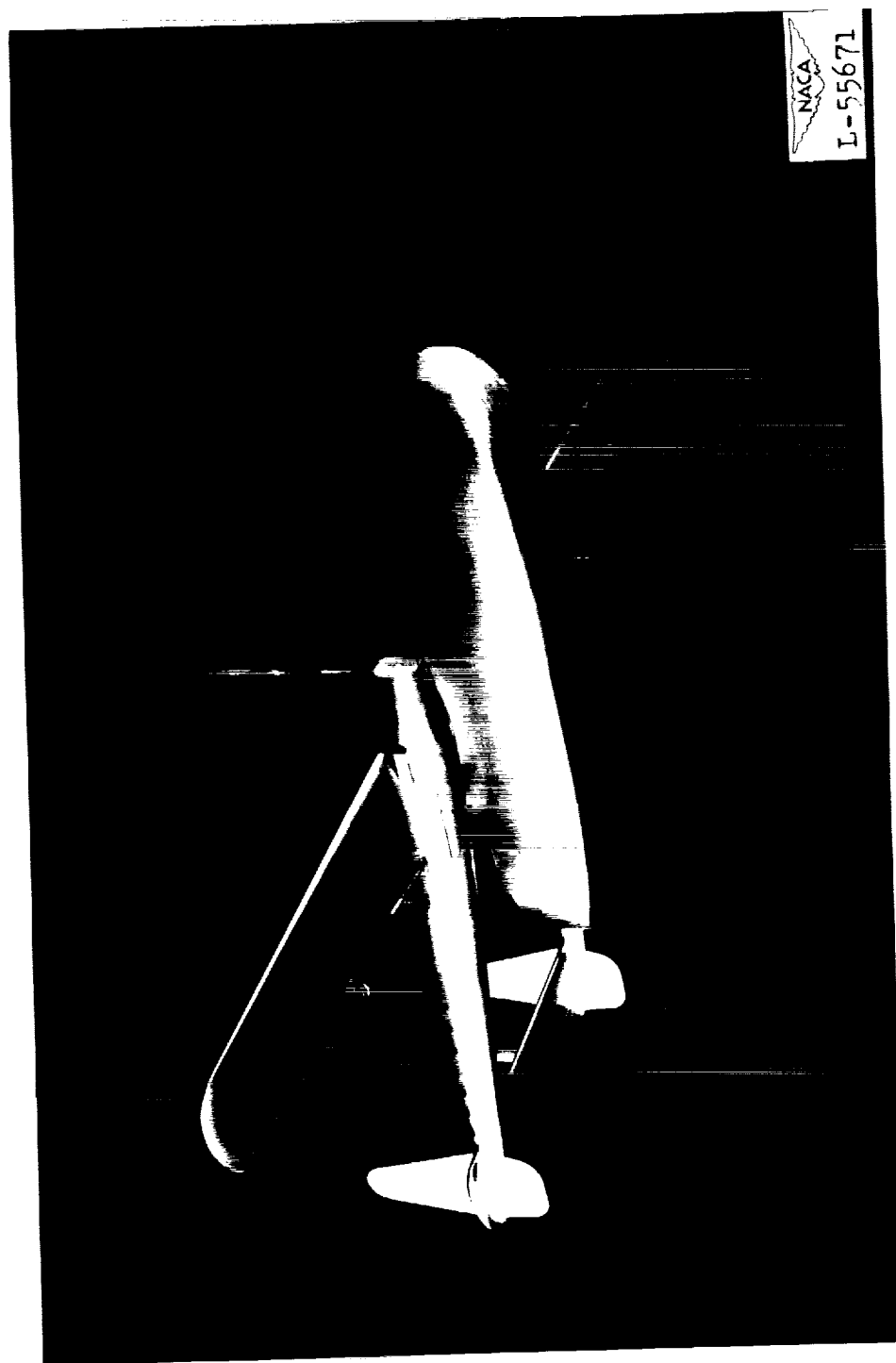
(a) Front view.

Figure 2.- Fairchild C-82 airplane,  $\frac{1}{15}$ -scale dynamic model.



(b) Side view.

Figure 2.- Continued.



(c) Three-quarter view.

Figure 2.- Concluded.

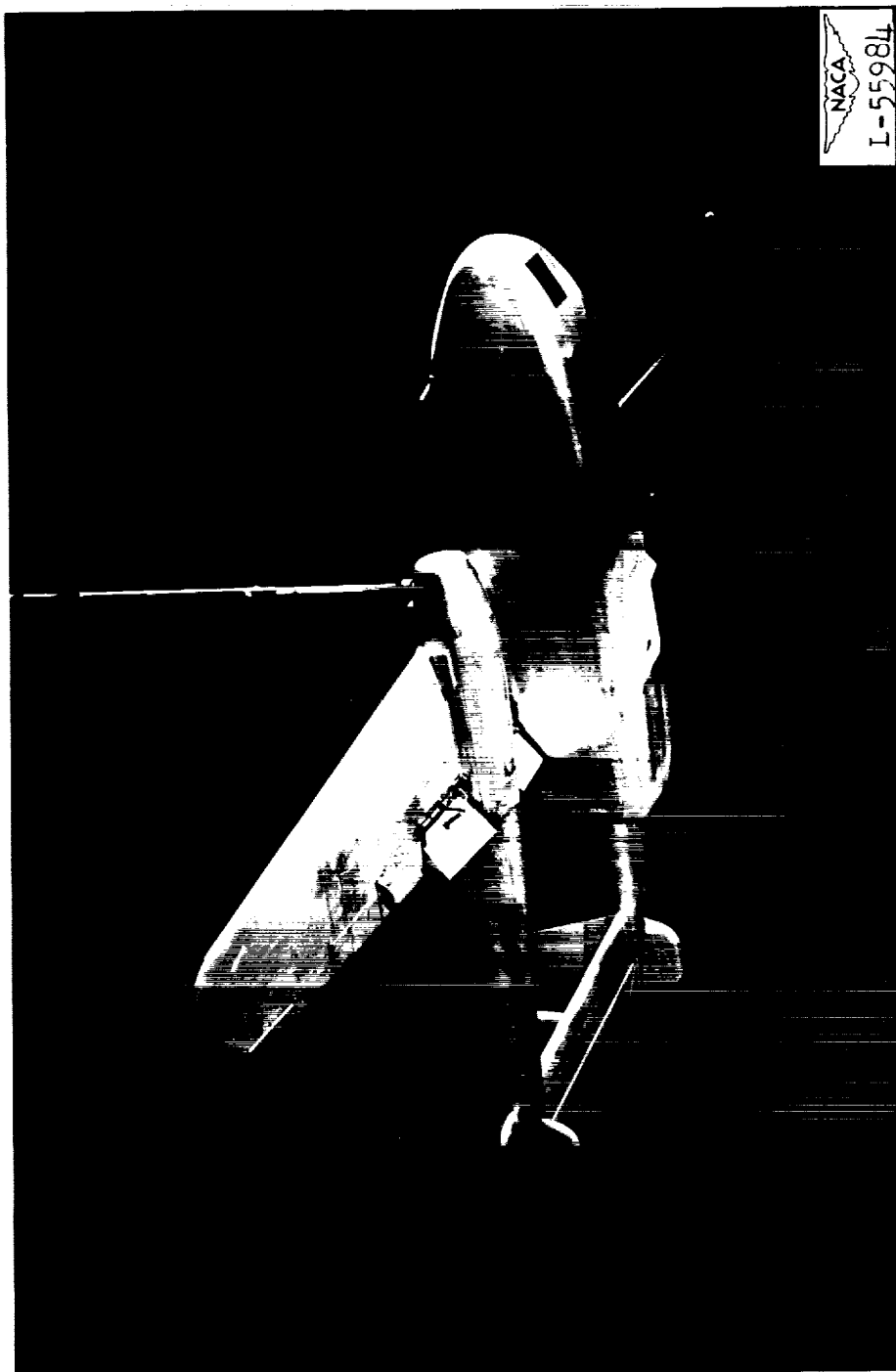


Figure 3.- Three-quarter view of model with nose-wheel doors and aft-cargo doors removed.

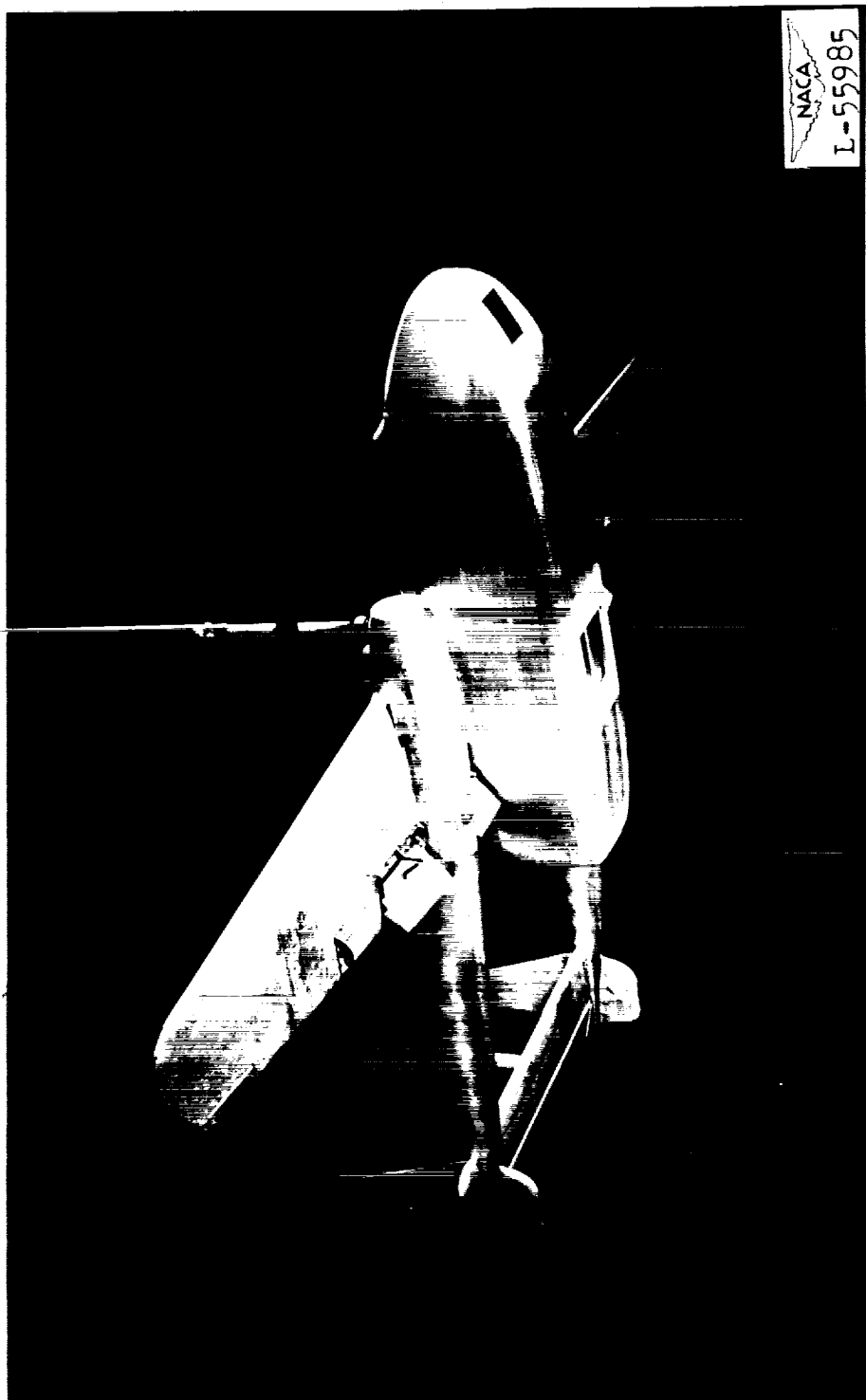


Figure L.- Three-quarter view of model with nose-wheel doors, aft-cargo doors, and paratainer hatch removed.



(a) No simulated damage. Time interval, 0.48 second.

Figure 5.- Sequence photographs. Landing attitude is  $12^{\circ}$ ; landing speed is 90 miles per hour. All values are full scale.





(b) Simulated failure of the nose-wheel doors and the aft-cargo doors. Time interval, 0.73 second.

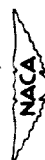
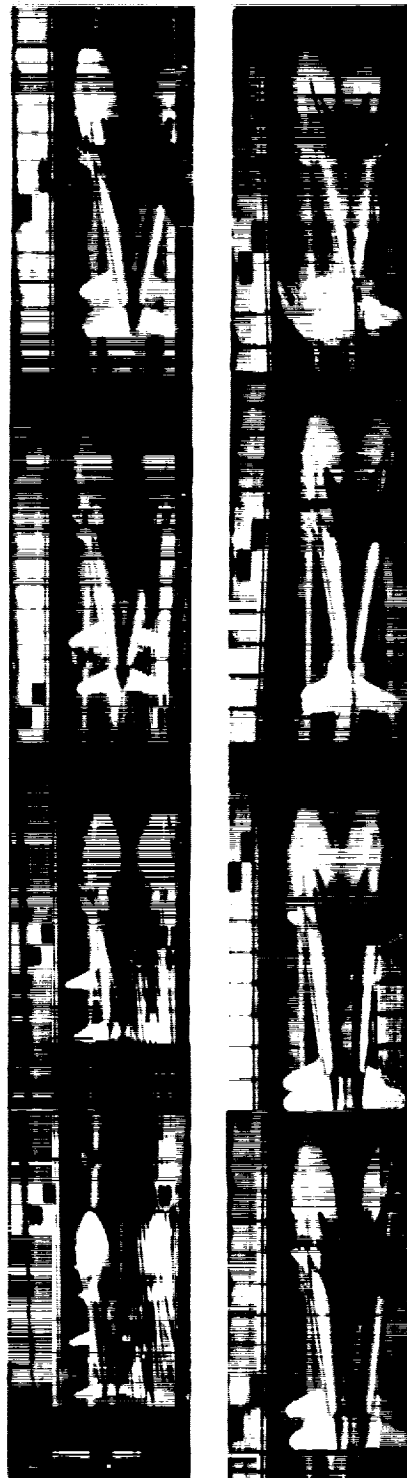


Figure 5.- Continued.



(c) Simulated failure of the nose-wheel doors, the aft-cargo doors, and the paratainer hatch. Time interval, 0.48 second.

Figure 5.- Concluded.



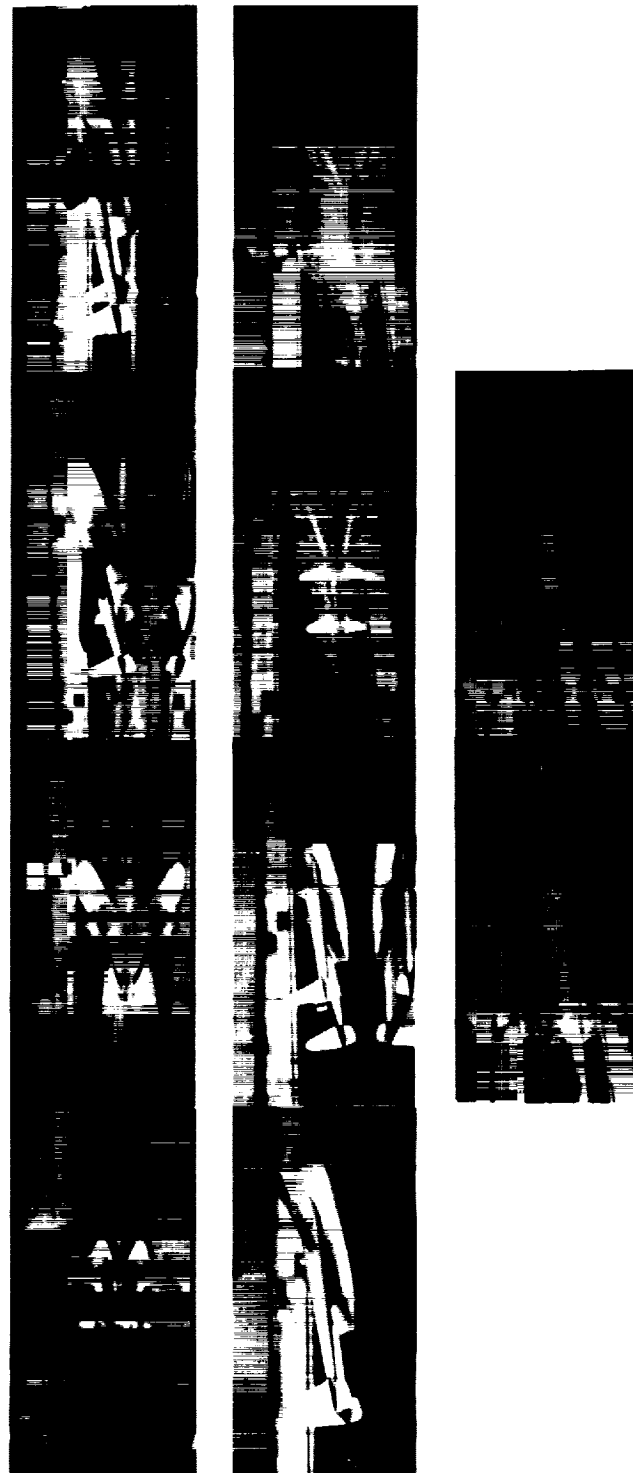
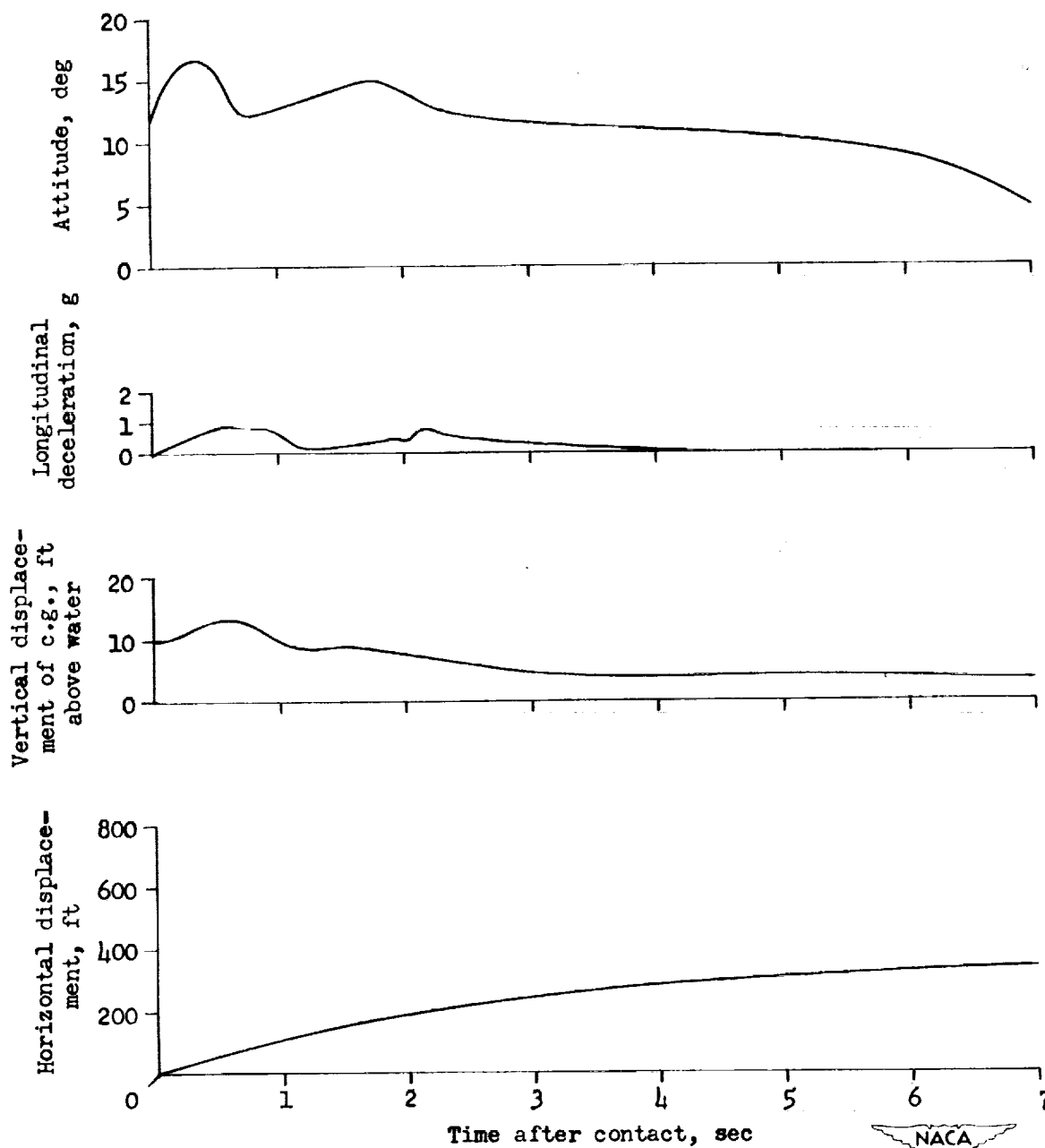


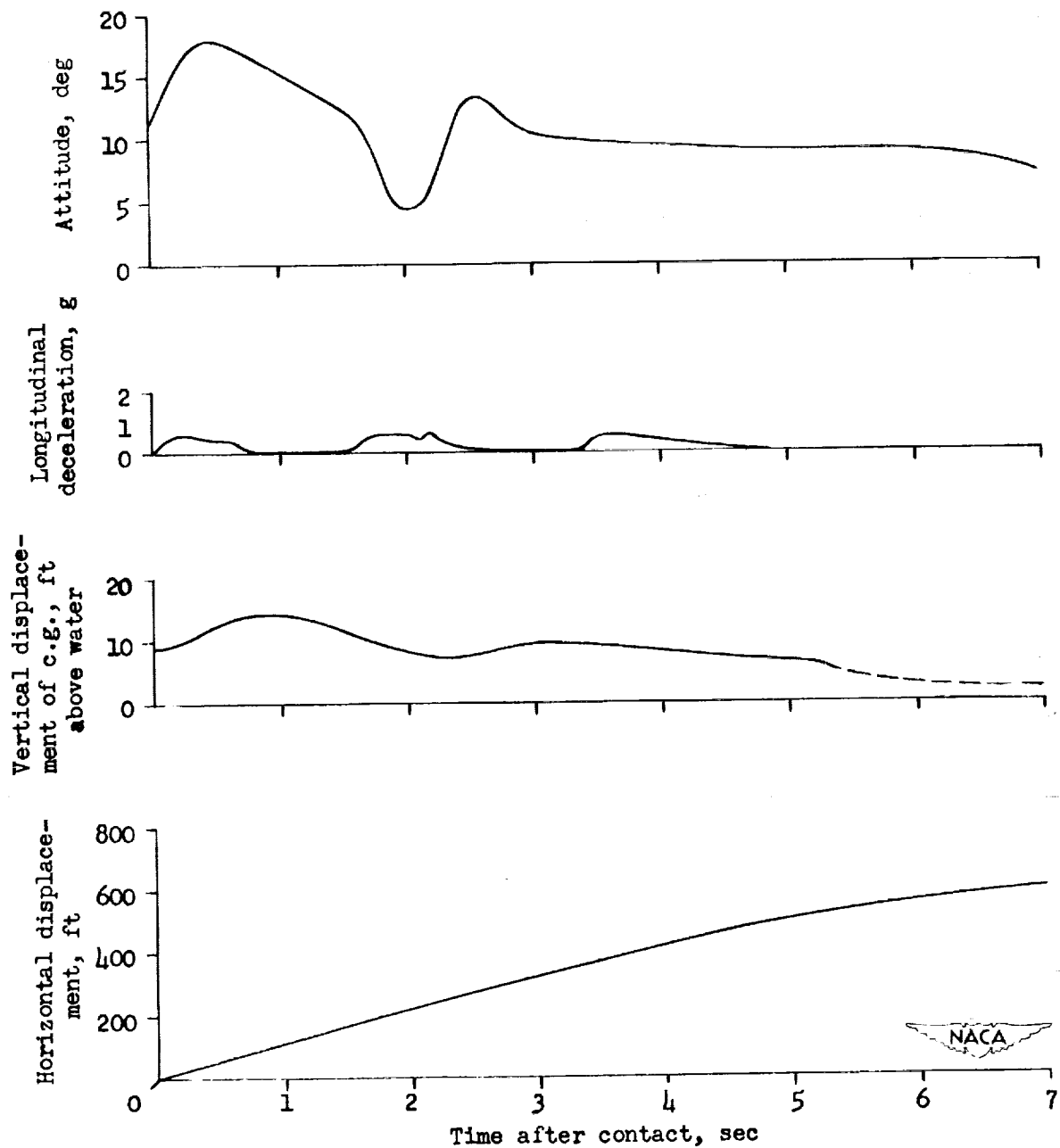
Figure 6.- Sequence photographs. Landing attitude is  $2^{\circ}$ ; landing speed is 125 miles per hour; time interval is 0.73 second; no damage is simulated. All values are full scale.





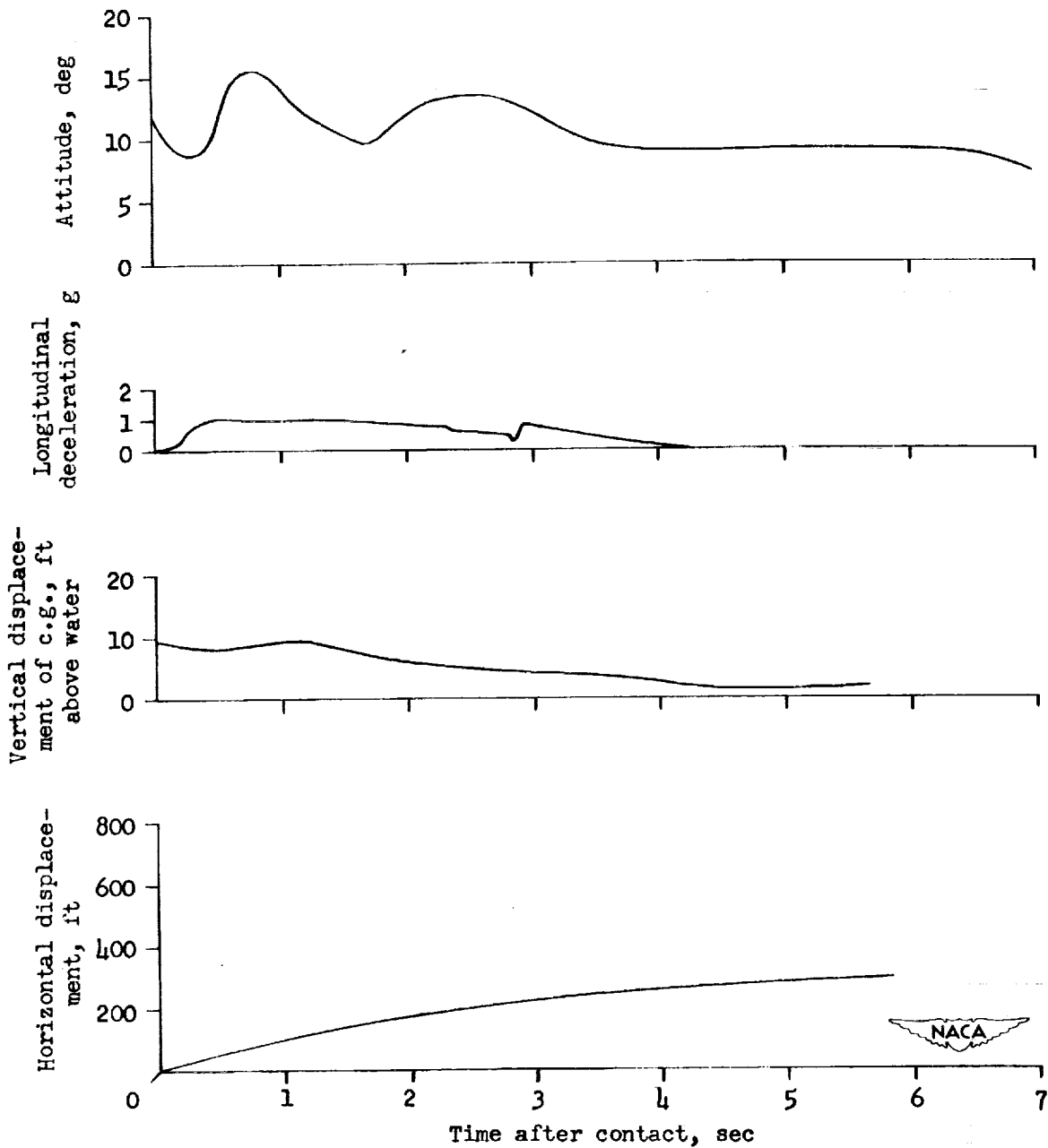
(a) No simulated damage.

Figure 7.- Typical curves of attitude, longitudinal deceleration, vertical displacement, and horizontal displacement. Landing attitude is  $12^\circ$ ; landing speed is 90 miles per hour. All values are full scale.



(b) Simulated failure of the nose-wheel doors and the aft-cargo doors.

Figure 7.- Continued.



(c) Simulated failure of the nose-wheel doors, the aft-cargo doors, and the paratainer hatch.

Figure 7.- Concluded.

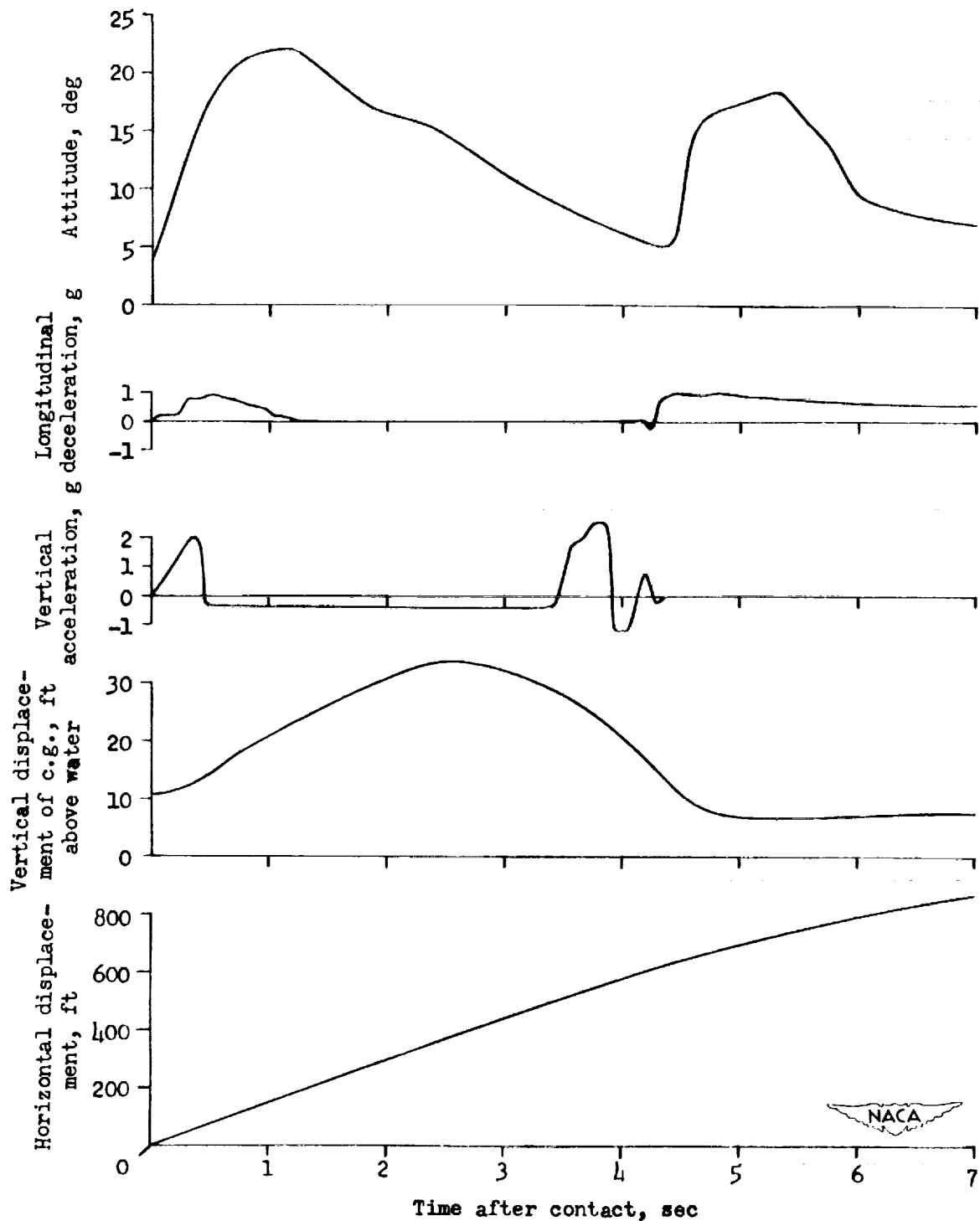


Figure 8.- Typical curves of attitude, longitudinal deceleration, vertical acceleration, vertical displacement, and horizontal displacement. Landing attitude is  $2^{\circ}$ ; landing speed is 125 miles per hour; no damage is simulated. All values are full scale.